TU Clausthal

DS 36.1

Clausthaler Zentrum für Materialtechnik

Interaction of oxygen with plasma-deposited Si:N:H primer coatings

L. Wurlitzer[1], O. Höfft[3] , Marcel Marschewski[2], S. Dahle[1,2] and W. Maus-Friedrichs[1,2]

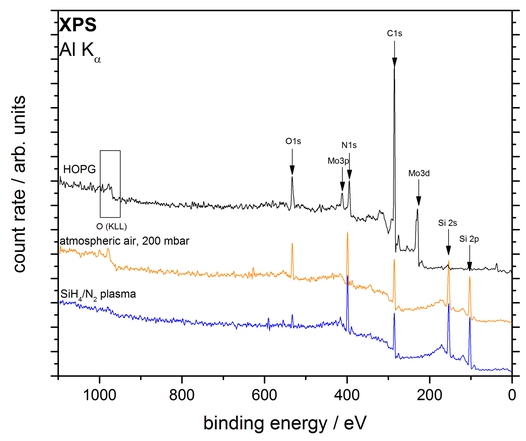
[1]Clausthal Centre of Material Technology, Clausthal University of Technology, Agricolastraße 2, D-38678 Clausthal-Zellerfeld, Germany
[2]Institute for Energy Research and Physical Technology, Clausthal University of Technology, Leibnizstraße 4, D-38678 Clausthal-Zellerfeld, Germany
[3]Institute for Electrical Chemistry , Clausthal University of Technology, Arnold-Sommerfeld-Straße 6, D-38678 Clausthal-Zellerfeld, Germany

Introduction

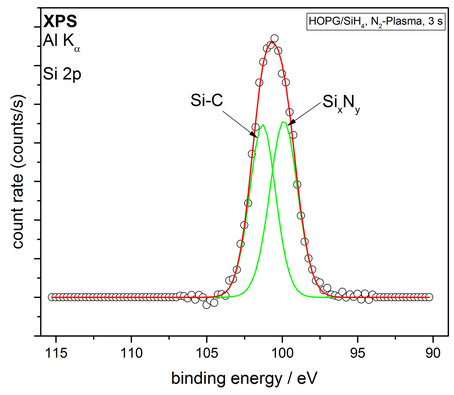
Silicon dioxide coatings are applied via a two step process using a dielectric barrier discharge (DBD) plasma treatment. In the first processing step a mixture of silane and nitrogen is employed for the DBD plasma treatment to deposit the primer Si:N:H coating. In the second step the primer coating is exposed to oxygen plasma treatment for a conversion into stoichiometric silicon dioxide. Without any plasma treatment small amounts of oxygen show a partial conversion of the primer coating. This high reactivity against oxygen is now investigated by small vapor pressures of atmospheric air in a ultra-high vacuum chamber on highly oriented pyrolytic graphite (HOPG) as substrate. This is compared to the interaction of the primer coating with an oxidic substrate while heating. Titanium due to its oxidated surface is used for substrate. To study the differences between the two ways of partial conversion of the primer coating X-ray photoelectron spectroscopy (XPS), photoemission spectroscopy (UPS) and metastable impact electron spectroscopy (MIES) are employed.

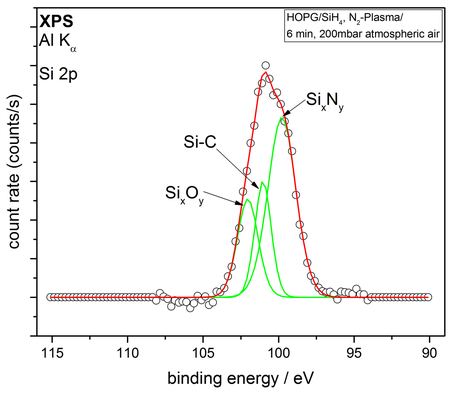
Interaction of primer coating with atmospheric air

Experimental:
- HOPG substrate (black spectrum)
- Plasma Treatment: DBD, 1 mm distance, 3 s, 200 mbar SiH_4/N_2 (blue spectrum)
- Oxygen exposure in 200 mbar atmospheric air, 6 min (orange spectrum)

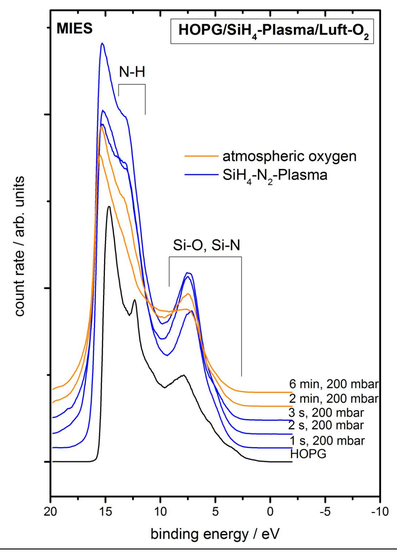


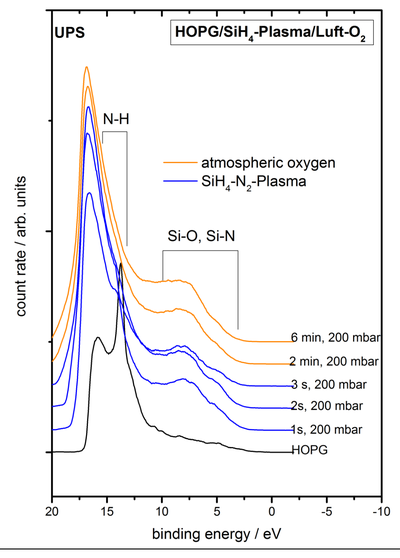
- Substrate coverage of Si and N with plasma treatment
- Oxygen treatment leads to higher amounts of oxygen no changing of nitrogen
- Detail spectra Si 2p:
  - Si_xN_y components occur with plasma treatment
  - Oxygen treatment shows Si_xO_y bondings





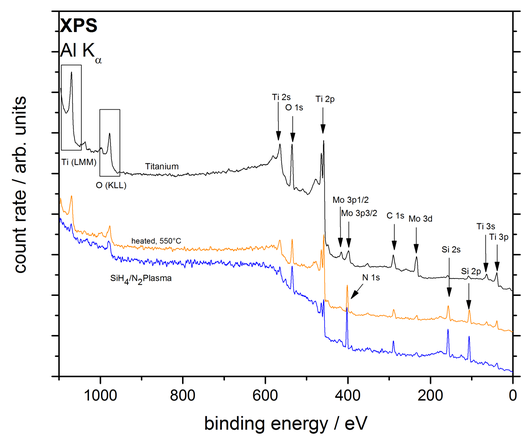
- N-H components are formed with plasma treatment
- Less amounts of N-H with oxidation
- Partial conversion from the primer coating into silicon oxide components



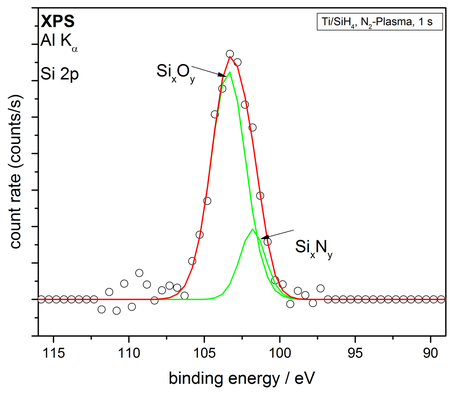


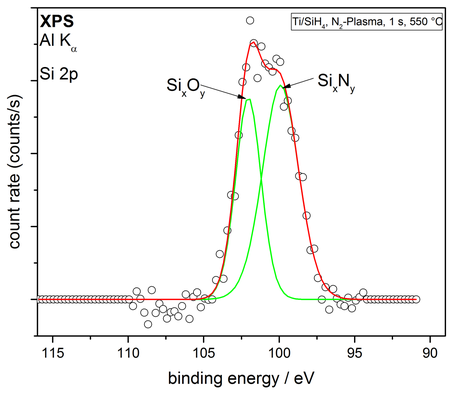
Interaction of primer coating with oxidic substrate

Experimental:
- Ti with TiO_2 substrate (black spectrum)
- Plasma treatment: DBD, 1 mm distance, 1 s, 200 mbar SiH_4/N_2 (blue spectrum)
- Oxygen exposure: heating substrate 550 °C

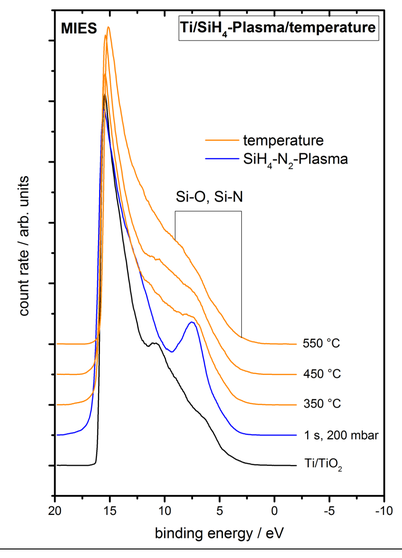


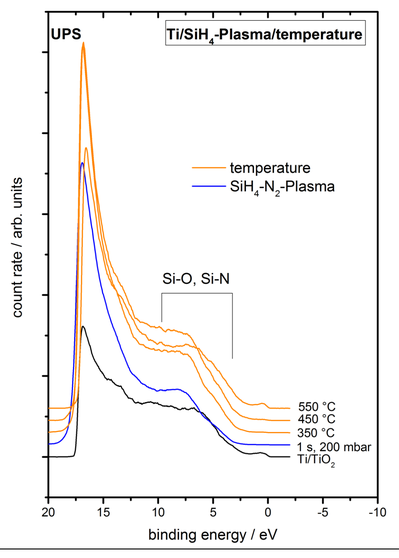
- Substrate includes oxygen
- Substrate coverage of silicon and nitrogen with plasma treatment
- Heating leads to less amounts of nitrogen and silicon → Removing im-purities, weak bonded components
- Detail spectra Si 2p:
  - Si_xN_y and Si_xO_y occur with plasma treatment
  - Conversion into Si_xO_y



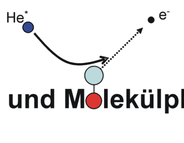


- Partial oxidation to silicon oxide components with plasma treatment
- Heating leads to a partial conversion from the primer coating Si:N into silicon oxide components
- Desorption of Si-O and Si-N components while heating





Clausthal Centre of Material Technology
Agricolastraße 2
38678 Clausthal-Zellerfeld
Tel.: + 49-(0)5323-72 3330
Fax: + 49-(0)5323 72 3198
www.czm.tu-clausthal.de



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